Patent Claims

 An electro-optical liquid-crystal display comprising a realignment layer, for realigning liquid crystals, and a liquid-crystalline medium of positive dielectric anisotrophy,

wherein said medium comprises one or more compounds of formula I

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$$R^1 - O \longrightarrow COO \longrightarrow$$

wherein

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R¹ is H, alkyl having 1 to 7 carbon atoms, alkoxy having 1 to 7 carbon atoms, alkenyl having 2 to 7 carbon atoms, alkenyloxy having 2 to 7 carbon atoms or alkoxyalkyl having 2 to 7 carbon atoms, and

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 \mathbf{Y}^{11} , \mathbf{Y}^{12} and \mathbf{Y}^{13} are each, independently of one another, H or F; and

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wherein when an electric voltage is applied to said display an electric field is generated which has a component parallel to the liquid-crystal layer for realignment of the liquid crystals.

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 A liquid-crystal display according to Claim 1, wherein said medium comprises one or more compounds of formula II:

$$R^2 - X^2 - X^2 - X^2$$

wherein

R²

is alkyl having 1 to 7 carbon atoms, alkoxy having 1 to 7 carbon atoms, alkenyl having 2 to 7 carbon atoms, alkenyloxy having 2 to 7 carbon atoms or alkoxyalkyl having 2 to 7 carbon atoms,

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$$A^{21}$$
 and A^{22}

are each, independently of one another,

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at least one of
$$A^{21}$$
 and A^{22}

and

$$-$$
 or $-$ or $-$

$$X^2$$
 is F, Cl or CN; and

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 Z^2 is $-CH_2CH_2-$, -COO-, $-CF_2O-$ or a single bond.

5 3. A liquid-crystal display according Claim 1, wherein said medium comprises at least one compound of formula III

$$R^{31}$$
 A^{31} Z^{31} A^{32} R^{32} |||

wherein

R³¹ and R³² are each, independently of one another, alkyl having 1 to 7 carbon atoms, alkoxy having 1 to 7 carbon atoms, alkenyl having 2 to 7 carbon atoms, alkenyloxy having 2 to 7 carbon atoms or alkoxyalkyl having 2 to 7 carbon atoms atoms,

25 Z^{31} is -CH=CH-, -COO-, -CH₂CH₂- or a single bond.

 A liquid-crystal display according Claim 2, wherein said medium comprises at least one compound of formula III

$$R^{31} \xrightarrow{A^{31}} Z^{31} \xrightarrow{A^{32}} R^{32}$$

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wherein

R³¹ and R³² are each, independently of one another,

alkyl having 1 to 7 carbon atoms,
alkoxy having 1 to 7 carbon atoms,
alkenyl having 2 to 7 carbon atoms,
alkenyloxy having 2 to 7 carbon atoms
or alkoxyalkyl having 2 to 7 carbon
atoms,

 $\rm Z^{31}$ is -CH=CH-, -COO-, -CH_2CH_2- or a single bond.

A liquid-crystal display according Claim 1,
 wherein said medium comprises at least one compound of formula IV

$$R^4 = A^{41} - Z^{41} - A^{42} - Z^{42} = 0$$

25 wherein

R⁴ is alkyl having 1 to 7 carbon atoms, alkoxy having 1 to 7 carbon atoms, alkenyl having 2 to 7 carbon atoms, alkenyloxy having 2 to 7 carbon atoms or alkoxyalkyl having 2 to 7 carbon atoms,

$$A^{41}$$
 $-$ and A^{42} $-$

5 are each, independently of one another,

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 $\rm Z^{41}$ and $\rm Z^{42}$ are each, independently of one another, $-\rm CF_2O^-, -COO^-, -\rm CH_2CH_2- \ or \ a \ single$ bond,

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n is 0 or 1,

Х

and

is OCF3, OCF2H or F,

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 Υ^{41} and Υ^{42} are each, independently of one another, H or F.

6. A liquid-crystal display according Claim 2,
25 wherein said medium comprises at least one compound of formula IV

$$R^{4} = A^{41} - Z^{41} - A^{42} - Z^{42} = 0$$

$$X$$

$$Y^{41} = X$$

$$Y^{41} = X$$

$$Y^{41} = X$$

$$Y^{42} = X$$

$$Y^{41} = X$$

$$Y^{41} = X$$

$$Y^{42} = X$$

$$Y^$$

wherein

5 R4

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is alkyl having 1 to 7 carbon atoms, alkoxy having 1 to 7 carbon atoms, alkenyl having 2 to 7 carbon atoms, alkenyloxy having 2 to 7 carbon atoms or alkoxyalkyl having 2 to 7 carbon atoms,

$$A^{41}$$
 and A^{42}

15 are each,

n

independently of one another,

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 $\rm Z^{41}$ and $\rm Z^{42}$ are each, independently of one another, $\rm -CF_2O^-, -COO^-, -CH_2CH_2- \ or \ a \ single \ bond,$

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is 0 or 1,

Χ

is OCF3, OCF2H or F,

and

- \mathbf{Y}^{41} and \mathbf{Y}^{42} are each, independently of one another, H or F.
- A liquid-crystal display according Claim 7. wherein said medium comprises at least one compound of formula IV 10

$$R^4 = A^{41} - Z^{41} - A^{42} - Z^{42} = 0$$

wherein

R4

is alkyl having 1 to 7 carbon atoms, alkoxy having 1 to 7 carbon alkenyl having 2 to 7 carbon atoms, alkenyloxy having 2 to 7 carbon atoms or alkoxyalkyl having 2 to 7 carbon atoms,

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$$A^{41}$$
 $-$ and A^{42} $-$

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are each, independently of one another,

 Z^{41} and Z^{42} are each, independently of one another, $-CF_2O^-, \ -COO^-, \ -CH_2CH_2- \ \ or \ \ a \ \ single$ bond,

n is 0 or 1,

10 X is OCF3, OCF2H or F,

and

 Υ^{41} and Υ^{42} are each, independently of one another, 15 $\,$ H or F.

 A liquid-crystal display according Claim 4, wherein said medium comprises at least one compound of formula IV

$$R^4 = A^{41} - Z^{41} - A^{42} - Z^{42} = 0$$

wherein

25 R⁴ is alkyl having 1 to 7 carbon atoms, alkoxy having 1 to 7 carbon atoms, alkenyl having 2 to 7 carbon atoms, alkenyloxy having 2 to 7 carbon atoms

or alkoxyalkyl having 2 to 7 carbon atoms,

$$A^{41}$$
 and A^{42}

are each,

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independently of one another,

 Z^{41} and Z^{42} are each, independently of one another, $-CF_2O^-, \; -COO^-, \; -CH_2CH_2- \; \; \text{or a single} \\ \text{bond,}$

n is 0 or 1,

20 X is OCF_3 , OCF_2H or F,

and

 Υ^{41} and Υ^{42} are each, independently of one another, 25 $\,$ H or F.

 A liquid-crystal display according to Claim 2, wherein medium comprises one or more compounds of formulae IIa to IIg

$$R^2$$
 O COO O CN

$$R^2 \longrightarrow 0 \longrightarrow CN$$

$$R^2$$
 O O CN

$$R^2 \xrightarrow{F} O \xrightarrow{F} O \xrightarrow{N} CN$$

$$R^2 \longrightarrow 0$$
 $O \longrightarrow NCS$

 A liquid-crystal display according to Claim 4, wherein medium comprises one or more compounds of formulae IIa to IIg

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llb

$$R^2$$
 O COO O CN

$$R^2$$
 O CN

$$R^2$$
 O CN

$$R^2$$
 O O CN

$$R^2$$
 O CN CN

$$R^2 \xrightarrow{O} O \xrightarrow{F} NCS$$

5 11. A liquid-crystal display according Claim 3, wherein said medium comprises one or more compounds of formulae IIIa to IIIc

$$C_{n}H_{\overline{2n+1}} - CH = CH - C_{m}H_{2m+1} - CH = CH - C_{m}H_{2m+1}$$

$$C_{n}H_{2n+1} - CH = CH - CH_{\overline{2n+1}} - CH = CH_{\overline{2n+1}} - CH = CH_{\overline{2n+1}} - CH = CH_{\overline{2n+1}} - CH_{\overline{2n+1}$$

wherein

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k is 1, 2, 3, 4 or 5,

m and n are each 0, 1, 2 or 3,

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is ≤5, and

0

m + n

is 0 or 1.

- 12. A liquid-crystal display according to Claim 8, wherein said medium comprises
 - 1 to 35% of one or more compounds of the formula I,
- 20 3 to 30% of one or more compounds of the formula II,
 - 3 to 45% of one or more compounds of the formula III,

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and

- 5 to 60% by weight of at least one compound of the formula IV.

- 13. A liquid-crystal display according to Claim 1, wherein pixels of the display are addressed by means of an active matrix.
- 5 14. A liquid-crystalline medium of positive dielectric anisotropy comprising at least two liquid-crystal compounds

wherein

R¹

is H, alkyl having 1 to 7 carbon atoms, alkoxy having 1 to 7 carbon atoms, alkenyl having 2 to 7 carbon atoms, alkenyloxy having 2 to 7 carbon atoms or alkoxyalkyl having 2 to 7 carbon atoms, and

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 $\text{Y}^{11}, \ \text{Y}^{12}$ and Y^{13} are each, independently of one another, H or F.

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15. In a method of generating an electro-optical effect using a liquid-crystal display, the improvement wherein a display according to claim 1 is used to generate said effect.

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16. A liquid-crystal display according to claim 1, wherein said medium additionally comprises one or more compounds of formulae Va and Vb

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$$R^{51} \longrightarrow R^{52} \qquad \qquad Va$$

$$R^{51} \longrightarrow O \longrightarrow R^{52} \qquad \qquad Vb$$

in which R^{51} and R^{52} are each, independently of one another, alkyl or alkoxy having 1 to 7 carbon 5 atoms or alkenyl, alkenyloxy or alkoxyalkyl having 2 to 7 carbon atoms,

and/or

10 one or more compounds of formulae Vc and Vd

in which

 R^{51} and R^{52} independently of one another, are as defined above, and $Y^{51} \qquad \text{is H or F.}$

- 20 17. A liquid-crystal display according to Claim 8, wherein said medium comprises
 - 2 to 30% of one or more compounds of the formula I,
 - 5 to 25% of one or more compounds of the formula II,
- $^{\rm -}$ 5 to 40% of one or more compounds of the 30 $\,$ formula III,

and

- 5 to 50% by weight of at least one compound of the formula IV.
 - 18. A liquid crystal display according to claim 1, wherein said medium has a birefringence of <0.12, a flow viscosity at 20° of <30 mm² s⁻¹, a resistivity at 20°C of 5 x 10^{10} to 5 x 10^{13} Ω cm, a rotational viscosity at 20°C of <130 mPa s, and a clearing point above 60°C.
- 19. A liquid-crystal display according to claim 1, wherein said medium has a birefringence of 0.05-0.11.
 - 20. A liquid-crystal display according to claim 1, wherein said medium has a flow viscosity at 20°C of 15-25 mm² \cdot s⁻¹.
 - 21. A liquid-crystal display according to claim 1, wherein said medium has a resistivity at 20°C of 5 x 10^{11} to 5 x 10^{12} Ω cm.
 - 22. A liquid-crystal display according to claim 1, wherein said medium has a rotational viscosity at 20°C of 70-110 mPa s.
- 30 23. A liquid-crystal display according to claim 1, wherein said medium exhibits a storage stability of at least 1000 hours at -30° C.

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